Space Weather Technical Forecast

Issued on Sunday 27 October 2024 at 01:34 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing S1/Minor Solar Radiation Storm. M-flares expected, chance of further X-flares. Chance of G1-G2/Minor-Moderate geomagnetic storm intervals Days 1-2 (27-28 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High following a multi-part long duration flare that peaked at X1.8 at 26/0719UTC having originated from the vicinity of AR3872/AR3873.

There are currently twelve primary sunspot regions on the disc. The majority of the larger and more complex regions lie in the southeast of the disc, with three notable regions located here: AR3869, AR3872, and AR3873. AR3872 has evolved slowly over the past 24 hours and has seen the emergence of at least one defined delta spot. AR3876, also in the southeast demonstrated significant growth during the period with proliferation and maturation of a number of spots. AR3874 in the northeast has seen the proliferation and development of a number of small spots as well as the emergence of a faint, and marginal, delta spot to the north of the trailing portion. Most other regions on the disc are smaller but multiple regions have shown gradual development and there has been a general increase in sunspot activity.

The CME associated with the long duration X1.8 flare on 26 Oct has been modelled by Enlil to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1, were at Slow-ambient speeds around 320km/s. Wind speeds increased to around 350km/s around 1300UTC before sharply rising around 26/1535 UTC to peak at 500-510km/s. Speeds have since declined to 450 km/s but remain at Slightly Elevated levels. Density was Below Average to Average. The Interplanetary Magnetic Field (IMF) was initially Weak between 4-7nT, but saw an increase to Moderate 26/1134 UTC and a further jump around 26/1535 UTC to Strong, peaking at 27nT. Levels have gradually declined, but remain Strong. The north-south component, Bz, was initially weakly positive, becoming moderately positive around 26/1300 UTC before fluctuating strongly varying between -18nT/+20nT. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2), increasing Unsettled to Active (Kp 3-4) upon arrival of one or more glancing blows from CMEs, and potentially connection to the HSS from CH84/-.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was below S1 levels for much of the period, but on a gradual rising trend. A S1/Minor Radiation Storm has

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been ongoing since 26/1805 UTC. High energy electron flux (greater than 2MeV) observed by GOES16 remained at mainly Background with a diurnal peak at Moderate. The associated 24-hour fluence was well below the Active threshold, with 3.31e6 integrated flux observed at 27/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is expected, with occasional M-class flares considered likely and a chance of X-class flares, most probable from the numerous active regions in the southeast disc.

Solar Wind / Geomagnetic Activity: Ongoing CME enhancement is forecast to wane through 27 Oct. A further CME arrival associated with the X1.8 flare on 26 Oct is projected to arrive later Day 1, but more probably on Day 2 (28 Oct).

Solar winds are currently at Slightly Elevated levels but may peak at Elevated to Strong levels following subsequent CME influence 28 Oct. A return to mainly Background winds is currently expected by Day 4 (30 Oct).

Activity is expected to be Quiet to Active (Kp 2-4) during Days 1-2 (27-28 Oct) with a chance of peak G1/Minor to G2/Moderate Storm (Kp 5-6) conditions during as a result of combined HSS and ongoing and forecast CME influence. Activity is expected to return to Quiet to Unsettled levels by Day 3 (29 Oct), although further flare and CME activity from the numerous active regions in the southeast disc could change this.

Energetic Particles / Solar Radiation: The High energy proton flux at GOES-18 is currently at S1/Minor Radiation Storm levels, but is forecast to decline towards Moderate levels through Day 1 (27 Oct). Ongoing Chance of further S1-S2/Minor to Moderate Radiation storms, mainly Days 1-2 (27-28 Oct) associated with the X1.8 fare. High energy electron flux at GOES16 is forecast to remain at mainly Background levels, with the associated 24 hour fluence remaining well below the Active (1e8 integrated flux) threshold.

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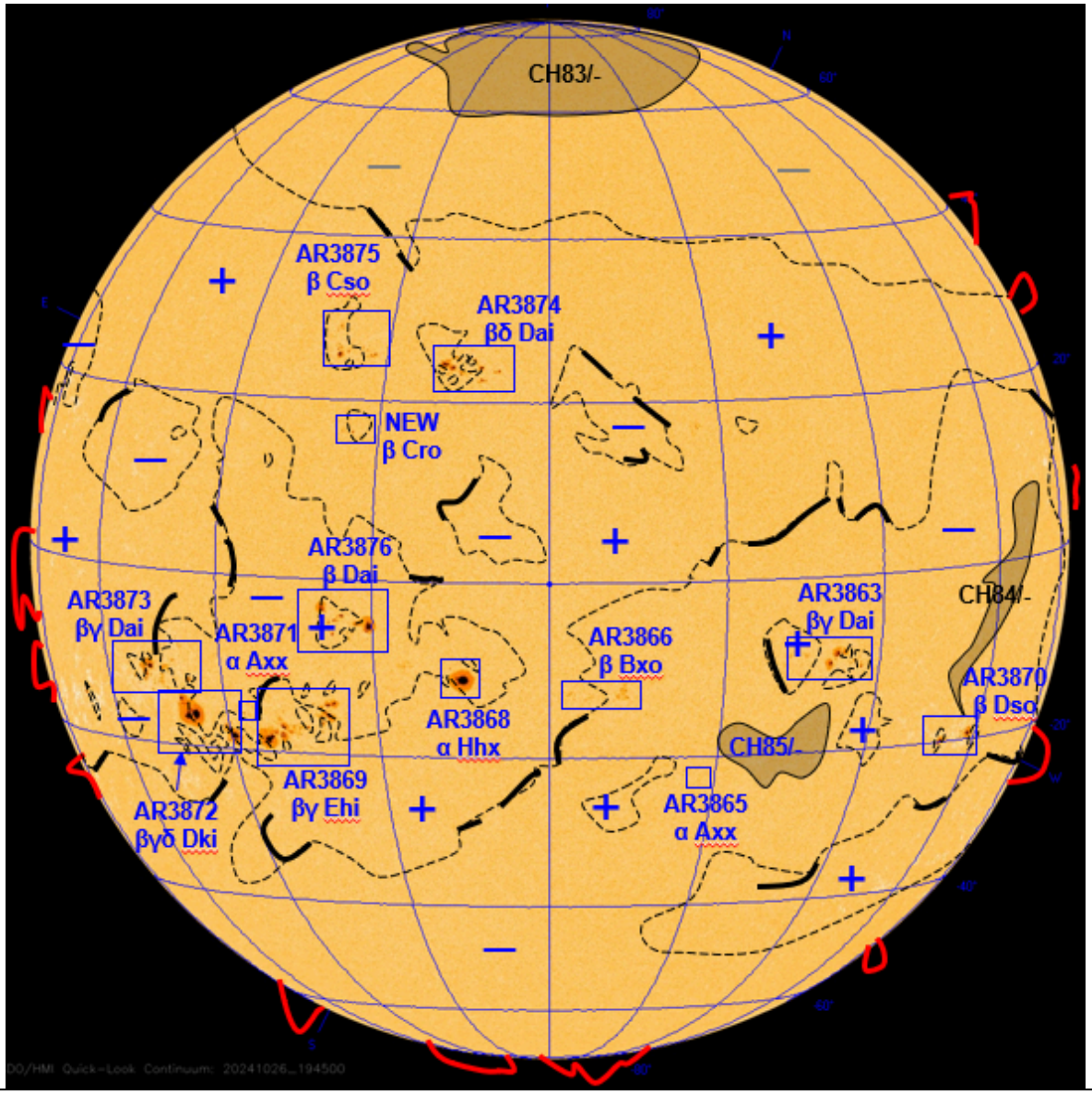
Figure 1: Solar Synoptic Map VT 26/2000UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME associated with the X3.3 flare on 24 Oct is considered to be responsible for the uptick in winds and geomagnetic activity around 26/1500 UTC, with ongoing enhancement underway and further enhancement still possible. A number of weak CMEs from 22-23 Oct were modelled to miss Earth but may have contributed to some of the Bz fluctuations observed during 26 Oct. The X1.8 flare on 26/0719 UTC from the vicinity of a number of complex regions in the southeast disc produced a CME that has been modelled to have an Earth-directed component. Although the bulk of ejecta is expected to pass behind the Earth, a significant shock is expected to arrive at Earth late Day 1 (27 Oct) or more probably during Day 2 (28 Oct). The forecast arrival time is complicated by the priming of the geomagnetic environment following previous strong flare activity.

Solar winds are currently at Slightly Elevated levels, around 450km/s. It is possible that CME influence may be masking enhancement from connection to a HSS from CH84/-, with wind speeds anticipated to remain at Slightly Elevated levels for much of Days 1-2. There is a chance that speeds may peak at Elevated to Strong levels given the potential for a more significant arrival during 28 Oct. A return to mainly Background winds is currently expected by Day 4 (30 Oct). SWPM has provided a reasonable steer for winds but becomes low confidence later in the period.

Activity is expected to be generally Unsettled to Active during Days 1-2 (27-28 Oct) with a chance of peak G1/Minor to G2/Moderate Storm conditions early Day 1 and again should geomagnetic conditions be favourable following the projected CME arrivals. Activity is expected to return to Quiet to Unsettled levels by Day 3 (29 Oct), although further flare and CME activity from the numerous active regions in the southeast disc could change this.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	30	30	5	5
Strong	**G3**	No	1	5	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-10-24 06:21	Partial	X3.3 flare (AR3869)	SE	1383	26/0700 UTC	Arrival considered around 26/1500 UTC.
2024-10-26 09:40	Partial	X1.8 flare	SE	1273	28/0500 UTC	Moderate confidence in Earth-directed shock. Arrival +/- 8hrs

Figure 2: MOSWOC Enlil

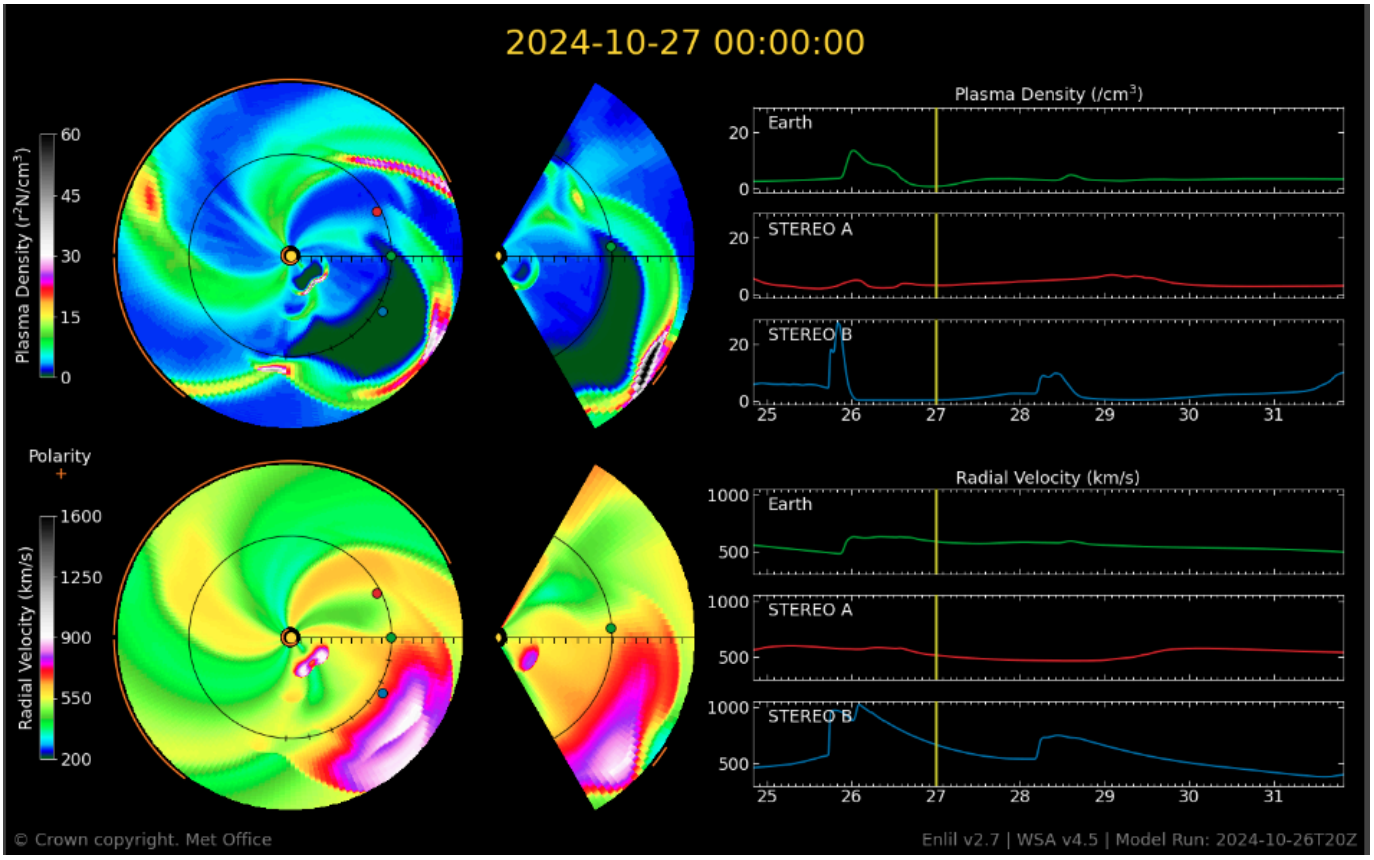

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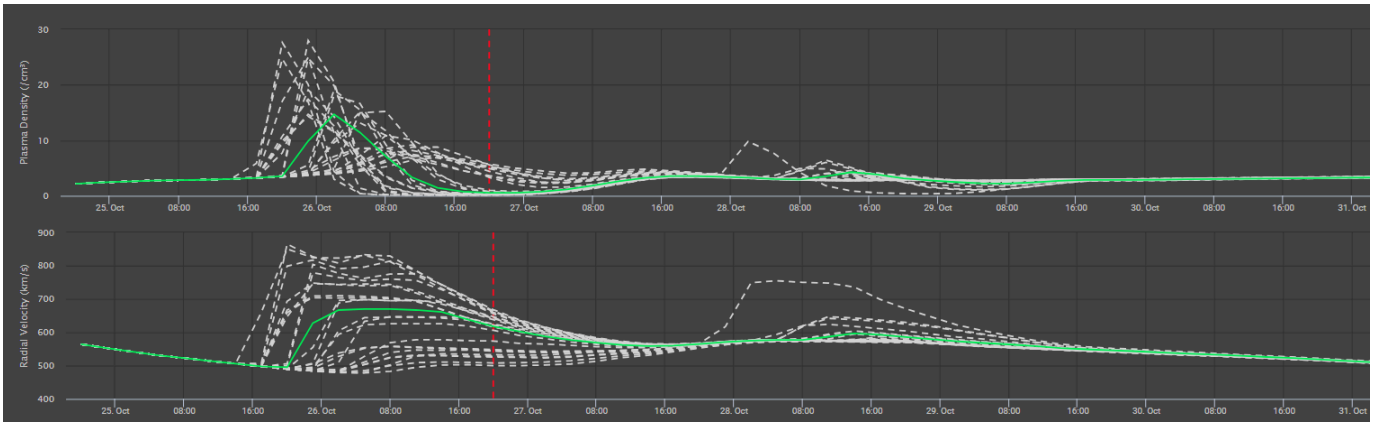
Figure 3: MOSWOC Enlil Ensemble showing spread in potential arrival times of CME enhancement



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Radio Blackouts - X-Ray Flares

There are currently twelve primary sunspot regions on the disc and the presence of an unnumbered Cro/Beta region in the southeast. The largest and most complex regions on the disc are in the southeast hemisphere with three notable regions located here: AR3869, AR3872, and AR3873. AR3869 (Ehi/Beta-Gamma) comprises of mature penumbra around both leading and trailing regions. Similarly AR3872 (Dki/Beta-Gamma-Delta) continues to slowly evolve and retains at least one delta configuration in the trailing portion, but with a less defined delta in the leading portion. AR3873 (Dai/Beta-Gamma) continues to rotate into clearer view, and has seen the proliferation of a number of small spots, mainly to the north of the lead portion. Most other regions on the disc are smaller but multiple regions showing gradual development and there appears to be a general increase in sunspot activity and complexity. AR3874 (Dai/Beta-Delta) has seen the proliferation and development of a number of small spots within the region as well as the emergence of a faint, and marginal, delta spot to the north of the trailing portion. AR3870 (Dso/Beta), in the southwest, has elongated and developed since last assessment with the proliferation and consolidation of the trailing portion.

Generally Moderate activity is forecast with occasional M-flares considered likely in the coming days given the number of sunspot regions and the growing complexity of the disk. There is the continued chance of further isolated X-flares. These risks increased have been increased from raw sunspot classification values given the recent history of the southeast cluster, and significant flares are most likely to originate from this region.

No significant sunspots are due to depart the disk during the period, while recurrence and far-side sounding imagery suggest only a muted signal for oncoming regions. Therefore the flare risk is kept largely steady through the period pending further developments.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	80	80	70	70
Very Active	**R3-R5 (X Class)**	Yes	20	20	20	20

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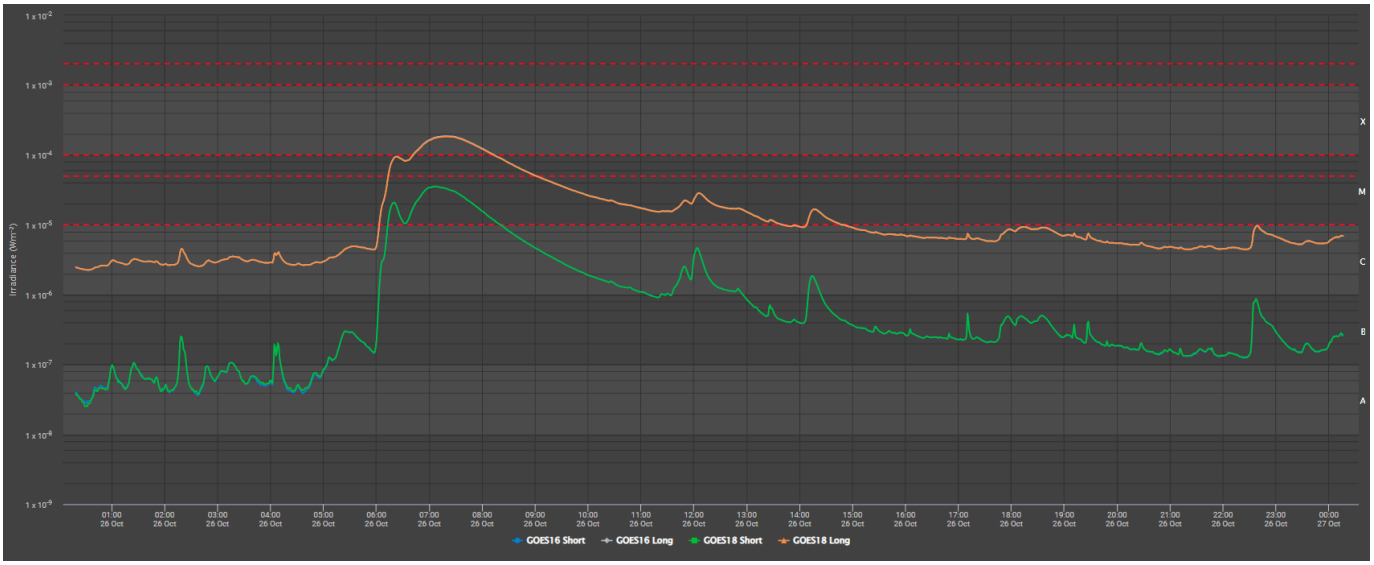
Figure 4: GOES16 and GOES18 X-ray trace over past 24 hours showing slow decline following the X1.8 flare



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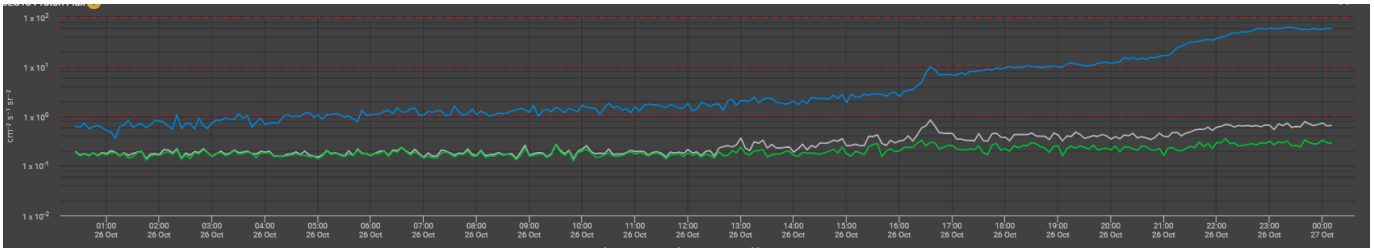
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 is currently at S1/Minor Radiation Storm levels, but is forecast to decline towards Moderate levels through Day 1 (27 Oct). Further S1-S2/Minor-Moderate radiation storms remain possible following the forecast arrival of a shock from the X1.8 flare and should the regions currently on the southeast disc produce any further significant flares as they rotate westward. The current most active regions are located near the east limb, but will gradually transit toward centre disc by the end of the period allowing for a slightly greater risk of proton enhancements late on. The values are flattened however, given ongoing enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	99	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: High Energy Proton trace for past 24 hours



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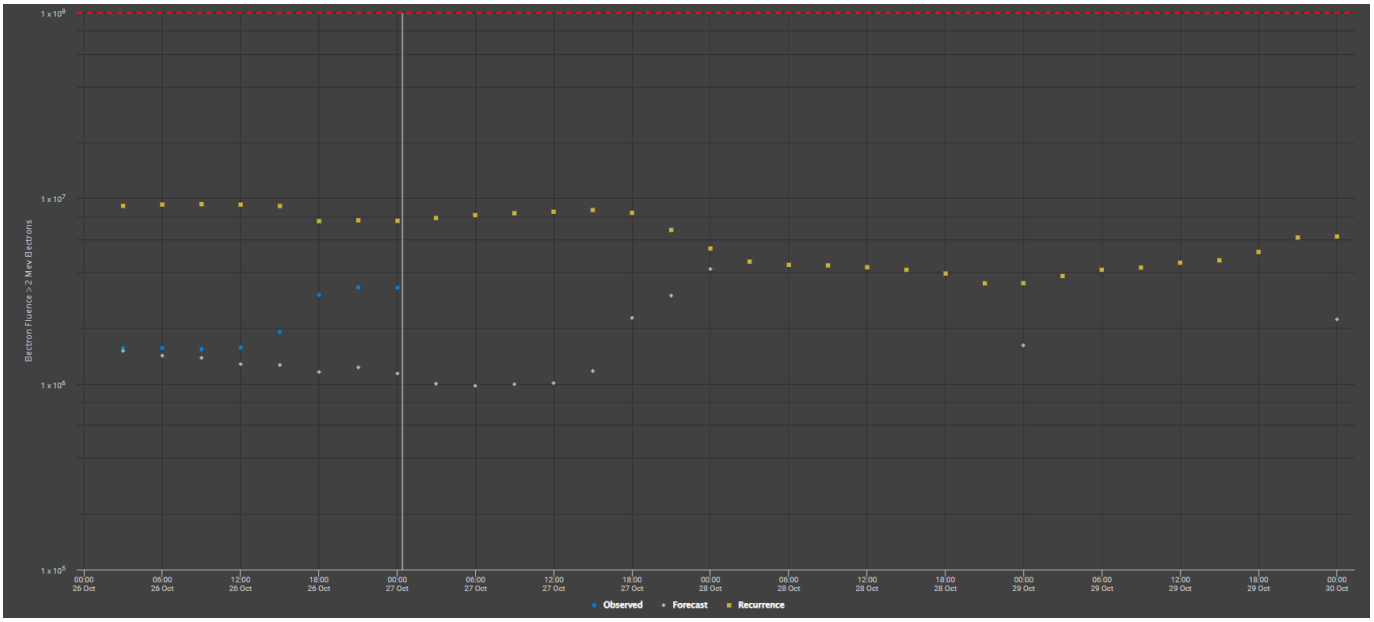
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Background levels, and is expected to persist mainly at this level. Ongoing and forecast CME enhancement may lead to an initial suppression in electron values, before a recovery later in the period.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: Latest MOSWOC REFM



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